

**UK Patent Application**      **GB**      **2 252 569 A**  
 (12)      (19)      (11)      (13)  
 (43) Date of A publication 12.08.1992

<p>(21) Application No 9202213.6</p> <p>(22) Date of filing 03.02.1992</p> <p>(30) Priority data                  (31) 9102562      (32) 06.02.1991      (33) GB</p>	<p>(51) INT CL<sup>5</sup>                  C23C 4/08 4/18, H01R 13/03</p> <p>(52) UK CL (Edition K)                  C7F FGA FP841 FR811 FR851 F809                  B2E EM E1722 E407S E408T E414T E424U E553T                  H2E EHPB                  U1S S1424 S2055 S2066</p>
<p>(71) Applicant  <b>BICC Public Limited Company</b>                  (Incorporated in the United Kingdom)    <b>Devonshire House, Mayfair Place, London, W1X 5FH,</b>  <b>United Kingdom</b></p> <p>(72) Inventor  <b>Gordon James Davidson</b></p> <p>(74) Agent and/or Address for Service  <b>M J Poole</b>  <b>BICC Public Limited Company, Patents &amp; Licensing</b>  <b>Department, Quantum House, Maylands Avenue,</b>  <b>Hemel Hempstead, Hertfordshire, HP2 4SJ,</b>  <b>United Kingdom</b></p>	<p>(56) Documents cited                  GB 1521455 A      GB 1489510 A      GB 1474841 A                  GB 1449162 A      GB 1238701 A      GB 1143081 A                  GB 1039633 A      GB 0979746 A</p> <p>(58) Field of search                  UK CL (Edition K) B2E, C7F FCSE FCSX FCVE                  FCVX FCXE FCXX FGA FGZ FPDE FPDY FPPE                  FPFX, H1N NMA, H2E EHPB                  INT CL<sup>5</sup> C23C, H01H, H01R                  Online databases: WPI</p>

**(54) Electric connectors formed of aluminium spray coated with copper**

(57) A bimetallic electric connector for copper to aluminium joints is made by first forming a bulk component of aluminium (typically a stock aluminium connector) and then coating an appropriate part of its surface with copper or a conductive copper alloy (such as brass) by a thermal spray coating technique, such as plasma spraying or gas-wire metallising. The coating may be porous, in which case the use of a pore sealant e.g. an air-drying glyceride resin is recommended and this may also form a corrosion-resistant layer over the edge of the copper (or copper alloy) coating. Suitable coating and sealing techniques are commercially available. The technique is less expensive than conventional friction welding, and offers additional design flexibility. The connector illustrated in Fig. 1 comprises an aluminium tube 1 flattened at one end to form a palm 2 through which are formed holes 3, 3, the entire surface area to the left of the line 4 being coated with copper.

*Fig. 1.*

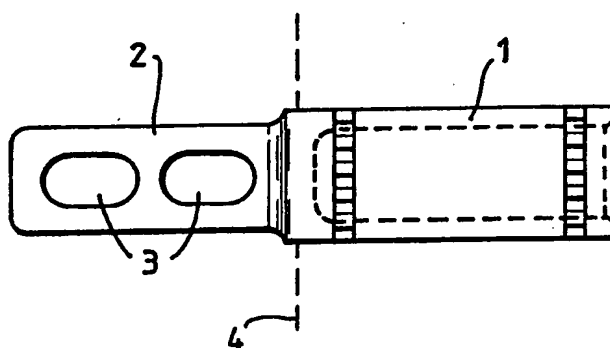


Fig.1.

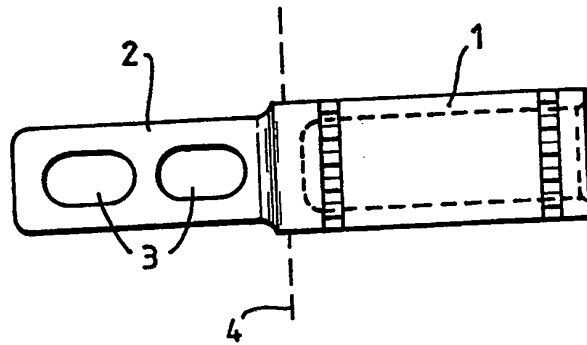
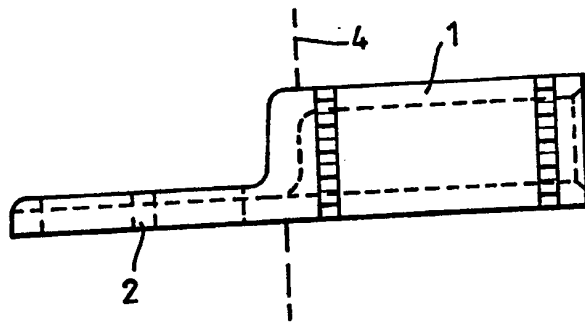


Fig. 2.



-1-

Electric Connectors and methods of making them

This invention relates to electrical connectors, more especially bimetal connectors for interconnecting aluminium and copper conductors, and methods of making them. Conductors of overhead lines and cables for the bulk distribution of electricity  
5 are normally made of aluminium (or a high-conductivity aluminium alloy, hereinafter included in the term "aluminium") on account of economic factors and its high conductivity per unit mass. On the other hand, internal  
10 wiring in consumers' premises normally uses copper conductors as they more easily form reliable connections, especially in small conductor sizes.

At some appropriate point, therefore, a transition has to be made from an aluminium conductor to a copper one.  
15 For this purpose bimetal connectors of appropriate geometry are used, comprising an aluminium part and a part of copper or a copper alloy (such as brass). The parts need to be secured together in a way that ensures a stable low-resistance current path between them. Mechanical  
20 connections are not considered satisfactory, because of the risk of "creep" under thermal cycling resulting in the loss of contact pressure, and bonding processes involving the use of molten metal are excluded by the risk of forming brittle, high resistance Cu/Al phases at the  
25 interface and/or by the natural oxide film on the

aluminium inhibiting contact.

Present practice is therefore to use bimetal connectors formed by solid-state friction-welding of aluminium and copper (or copper alloy) rods or tubes.

5 This is expensive and limits design flexibility as the actual aluminium/copper interface must almost inevitably be a nominally plane surface perpendicular to the axis of the initial rods/tubes.

In accordance with the invention, an electric

10 connector comprises a bulk component made of aluminium and a coating on a part of the bulk component made of copper or a conductive copper alloy and applied by thermal spray coating.

In most cases the bulk component can be a standard

15 connector for aluminium conductors, and the invention includes a method of making a bimetal electric connector comprising first forming a connector of aluminium and then coating part of its surface with copper or a conductive copper alloy by thermal spray coating.

20 Various thermal spray coating techniques can be used, such as plasma spraying, gas-wire metallising and the proprietary technique offered under the designation "Thermospray" by Metco Limited of Chobham, Surrey GU24 8RD: (and in the USA by the Metco division of Perkin-Elmer

25 Corp, of 1101 Prospect Avenue, Westbury NY 11590). Coatings of pure copper are preferred, but brass might be used in some cases.

If, as is normally the case, the thermal spray coating

is porous, we very much prefer to seal it by the application of a suitably penetrating high-solids liquid sealant, several of which are available and recommended for sealing thermal spray coatings used for other purposes. The sealant may also be applied as a corrosion-resisting insulating layer extending across the edge of the coating, avoiding the need for the paint banding operation normally used on conventional bimetal connectors. Excess sealant may be abraded away, if found necessary, from the contact areas of the coating.

The invention can be used to make bimetal connectors of many shapes and sizes to suit particular applications. One important style of connector comprises a tubular part for compression jointing (crimping) onto an aluminium conductor and a flat part (usually referred to as a "palm") with one or more apertures to facilitate bolting to a relatively rigid conductor or terminal of copper or brass; in this case it is preferred that the whole of the area of the palm (including the surface(s) of the hole(s), in particular) plus the transition area between the palm and the tubular part to be coated with copper or copper alloy as described. This results in the formation of a surface bimetal interface in a position where a corrosion-resisting seal (either the sealant already described or a separate band of coating, such as paint) can be easily applied and easily inspected.

The invention will be further described by way of example with reference to the accompanying drawings in

which figures 1 and 2 are mutually perpendicular view of one form of bimetal connector in accordance with the invention.

The connector comprises a length of electrical grade  
5 aluminium tube 1 flattened at one end to form a palm 2  
through which are formed holes 3,3 (of circular or other  
suitable cross-section) for the reception of bolts. As so  
far described, the connector is a stock item for crimping  
to a circular aluminium conductor and bolting to other  
10 conductors of aluminium or compatible material. In  
accordance with the invention, the entire surface area of  
the connector to the left of the line 4 is coated with  
copper by plasma spraying to the "P55-10" process operated  
by Metco Limited. Following this operation, the copper  
15 coating is sealed by spraying with the 95% soldis air-  
drying glyceride resin solution sold by Metco Ltd under  
the designation Metco AG. This sealant is applied not  
only to seal pores throughout the copper coating but also  
to form an insulating and corrosion-resisting layer  
20 extending for at least a few millimetres on each side of  
the edge of the coating as a corrosion inhibitor. After  
standing in air for 15 minutes, excess sealant is wiped  
from the flat areas of the palm 2 with a clean dry cloth.  
It may be desirable, with this particular sealant, to  
25 allow a week's storage at ambient temperature (or an hour  
at 145°C) after evaporation of solvent is complete) for  
curing, prior to use of the connector.

CLAIMS

1. An electric connector comprising a bulk component made of aluminium and a coating on a part of the bulk component made of copper or a conductive copper alloy and applied by thermal spray coating.
- 5 2. An electric connector in accordance with Claim 1 comprising a tubular part for compression jointing onto an aluminium conductor and a flat apertured palm and in which the said coating is applied to the whole of the area of the palm.
- 10 3. A connector as claimed in Claim 1 or Claim 2 in which the coating is applied by plasma spraying.
4. A connector as claimed in Claim 1 or Claim 2 in which the coating is applied by gas-wire metallising.
5. A method of making a bimetal electric connector  
15 comprising first forming a connector of aluminium and then coating part of its surface with copper or a conductive copper alloy by thermal spray coating.
6. A method as claimed in Claim 5 in which the copper or conductive copper alloy is applied by plasma spraying.
- 20 7. A method as claimed in Claim 5 in which the copper or conductive copper alloy is applied by gas-wire metallising.
8. A connector as claimed in any one of the preceding claims in which the said coating is porous and is sealed  
25 by application of a penetrating high-solids liquid sealant.
9. A connector as claimed in claim 8 in which the sealant

also forms a corrosion resistant layer over the edge of the said coating.

10. A bimetal electric connector substantially as described with reference to the accompanying drawings.

5 11. A method of making a bimetal connector substantially as hereinbefore described by way of example.



**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Applica~~tion~~ number

9202213.6

**Relevant Technical fields**

- (i) UK CI (Edition K ) C7F (FGA, FGZ, FCSE, FCSX, FCXE, FCXX, FCVE, FCVX, FPDE, FPDX) B2E; H2E (EHPB); H1N (NMA)  
(ii) Int CI (Edition 5 ) C23C; H01H; H01R

**Search Examiner**

P G BEDDOE

**Databases (see over)**

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

**Date of Search**

17.3.92

Documents considered relevant following a search in respect of claims

1-11

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
Y	GB 1521455 A (NATIONALE) see especially page 3 lines 38-53	1,3,5,6
Y	GB 1489510 A (DELTA) see especially page 2 lines 17-33	1,3-7
Y	GB 1474841 A (TELEMECANIQUE) see especially page 1 lines 76-86; Claim 1	1,3-7
Y	GB 1449162 A (WELLWORTHY) see especially page 2 lines 25-52	1,3-7
Y	GB 1238701 A (KALLE) see especially page 2 lines 42-63	1,3,5,6
Y	GB 1143081 A (ALUMINIUM) see especially Figure 1; page 2 lines 44-65	1-7
Y	GB 1039633 A (METCO) see especially page 4 lines 54-59, lines 66-75	1,3,5,6
Y	GB 979746 A (WESTINGHOUSE) see especially page 1 lines 61-76	1,3,5,6, 8,9

SF2(p)

1dt - c:\wp51\doc99\fil000299

Category	Identity of document and relevant passages -8-	Relevant to claim(s)

#### Categories of documents

**X:** Document indicating lack of novelty or of inventive step.

**Y:** Document indicating lack of inventive step if combined with one or more other documents of the same category.

**A:** Document indicating technological background and/or state of the art.

**P:** Document published on or after the declared priority date but before the filing date of the present application.

**E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.

**&:** Member of the same patent family, corresponding document.

**Databases:** The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

**This Page is Inserted by IFW Indexing and Scanning  
Operations and is not part of the Official Record**

**BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☒ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☐ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: \_\_\_\_\_

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.**